(4)

AD

AD-E401 849

TECHNICAL REPORT ARAED-TR-88019

PASCC1: PICATINNY ARSENAL SHAPED CHARGE CODE, ONE-DIMENSIONAL ANALYSIS VERSION 2.1

ERNEST L. BAKER

OCTOBER 1988

U. S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

ARMAMENT ENGINEERING DIRECTORATE

PICATINNY ARSENAL, NEW JERSEY

US ARMY
ARMAMENT MUNITIONS
& CHEMICAL COMMAND
ARMAMENT RDE CENTER

88 10 18 132

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER Technical Report ARAED-TR-88019	5. MONITORING ORGANIZATION REPORT NUMBER)
6a. NAME OF PERFORMING ORGANIZATION ARDEC, AED Energetics and Warheads Div — 6b. OFFICE SYMBOL SMCAR-AEE-WW	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (CITY, STATE, AND ZIP CODE) Picatinny Arsenal, NJ 07806-5000	7b. ADDRESS (CITY, STATE, AND ZIP CODE)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION ARDEC, IMD STINFO Br — 8b. OFFICE SYMBOL SMCAR-IMI-I	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (CITY, STATE, AND ZIP CODE) Picatinny Arsenal, NJ 07806-5000	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (INCLUDE SECURITY CLASSIFICATION)
PASSC1. PICATINNY ARSENAL SHAPED CHARGE CODE, ONE-DIMENSIONAL ANALYSIS VERSION 2 1

12. PERSONAL AUTHOR(S)
Ernest L. Baker

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (YEAR, MONTH, DAY)	15. PAGE COUNT
	FROM ________ TO ________	October 1988	30

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (CONTINUE ON REVERSE IF NECESSARY AND IDENTIFY BY BLOCK NUMBER)
FIELD	GROUP	SUB-GROUP	Shaped charge; Gurney formulation; Computer program; Pugh-Eichelberger-Rostoker formulation; Wave shaping

19. ABSTRACT (CONTINUE ON REVERSE IF NECESSARY AND IDENTIFY BY BLOCK NUMBER)

Picatinny Arsenal Shaped Charge Code, One-dimensional Analysis Version 2.1 (PASCC1) is a phenomenalogically based one-dimensional shaped charge program, resident on the CDC 825/74c at Picatinny Arsenal. PASCC1 has the capability of modeling a large variety of shaped charges, including shaped charges with axial explosive composition and density gradients, detonation wave shapers. variable body geometries, variable explosive charge geometries, and variable liner geometries. The shaped charge liner is treated as a series of liner points (mass points) The program uses accelerating Gurney formulation with constant gamma explosive products polytropic expansion to predict the acceleration of each liner point. The collapse angle of the liner is calculated using a modified Taylor Angle formulation, which compensates for liner point acceleration. The shaped charge jet parameters are calculated using the Pugh-Eichelberger-Rostoker jet/slug formulation.

Use of the program, as well as a preprocessor and post processor, is explained.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL I. HAZNEDARI	22b. TELEPHONE (INCLUDE AREA CODE) (201)724-3316 — 22c. OFFICE SYMBOL SMCAR-IMI-I

DD FORM 1473, 84 MAR

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

CONTENTS

FIGURES

INTRODUCTION

PASCC1 is a phenomenalogically based one-dimensional shaped charge program, resident on the CDC 825/74c at Picatinny Arsenal. PASCC1 was originally developed by the Energetics and Warheads Division of ARDEC in order to evaluate axial explosive density and composition gradient effects on shaped charge jet characteristics. PASCC1 has since been successfully used on a variety of shaped charge applications and is under continual development. PASCC1 has the capability of modeling a large variety of shaped charges, including shaped charges with: axial explosive composition and density gradients, detonation wave shapers, variable body geometries, variable explosive charge geometries, and variable liner geometries. The shaped charge liner is treated as a series of liner points (mass points). The program used accelerating Gurney formulation with constant gamma explosive products polytropic expansion to predict the acceleration of each liner point. The collapse angle of the liner is calculated using a modified Taylor angle formulation, which compensates for liner point acceleration. The shaped charge jet parameters are calculated using the Pugh-Eichelberger-Rostoker (ref 1) jet/slug formulation. A general review of shaped charge theory may be found in reference 2.

Input data can be generated either directly by hand (from drawings, explosive data, etc.) or by a preprocessor program. The currently used preprocessor program is LPASCC. LPASCC calculates the detonation sweep velocities along the liner using desired initiation, explosive, and liner configurations. An explosives library and a materials library exists in the program, but explosive and materials parameters can also be interactively input. When required, a thermo-chemical equation of state program, such as TIGER (ref 3), can be used to generate explosive input parameters.

The output data can either be evaluated directly by hand (read created data files, graph by hand, etc.) or by a postprocessor program. The currently used postprocessor program is GPASCC. GPASCC can plot a large variety of shaped charge parameters including liner mass point initial positions, liner collapse conditions, and jet conditions.

LPASCC

LPASCC is a preprocessor program used to generate input files for the program PASCC1. Either plane, point, or ring initiation can be specified. Bodies can be of constant thickness or the thickness can be fitted with a polynomial. A variety of body materials are included in the library, or desired material parameters can be interactively input. The explosive charge geometry can be cylindrical, cylindrical with a tapered cut, or fit with a polynomial. Possible body and explosive geometry input is shown in figure 1. The explosive material can have constant properties, or have axial density and composition gradients. A variety of explosive materials are included in the explosives library, or explosive properties can be interactively input. LPASCC includes three liner drivers: CONEL for cone liners, TRUMPI for trumpet liners, and VARIL for variable liners fit with polynomial and/or sinusoid functions. The required input for the three liner drivers is shown in figures 2, 3, and 4. The program can be run interactively on any terminal. Once the program execution begins, the program will prompt for all entry. To begin program execution the following command must be entered:

BEGIN,LPASCC,/PASCCL,outfile,id.

outfile = user supplied data filename (input file for PASCC1)
id = id under which outfile will be catalogued

PASCC1

PASCC1 does the liner collapse and jetting conditions calculations for a shaped charge using the geometry, material, explosive, and detonation data supplied in the input data file. the input data file is produced by LPASCC or by hand. The input data format is presented in appendix A. The liner collapse and jetting conditions are output in a file that can be reduced by the postprocessor program GPASCC or by hand. The output data format is presented in appendix B. PASCC1 can be executed by using the following command on the CDC 825/74C:

BEGIN,PASCC1,/PASCC1,infile,outfile,id.

infile = user supplied input data filename
outfile = user supplied output data filename
id = id under which infile is catalogued and outfile will be catalogued

Program PASCC1 should normally be executed in batch mode (i.e., the above command should be in a batch file).

GPASCC

GPASCC is a data reduction program used to evaluate results from program PASCC1. The program reduces and graphs data from PASCC1 output files. Many graphing options are available in the program, including line types and data symbols. A large variety of shaped charge parameters can be plotted including liner mass point initial positions, liner collapse conditions, jetting conditions, and jet profiles. The GPASCC plot menu is presented in figure 5. Some examples of GPASCC produced plots are presents in figure 6 and 7. The program must be run interactively on a graphics terminal (TEK4014, etc.). Once program execution begins, the program will prompt for all entry. To begin program execution the following command must be entered:

BEGIN,GPASCC,/PASCC1,infile,id.

infile = user supplied data filename (output file from PASCC1)
id = id under which infile will be catalogued

SUPPORT

In order to facilitate the initial use of PASCC1, an example shaped charge calculation is presented in appendix C. This manuscript will be periodically updated, as well as PASCC1 capabilities.

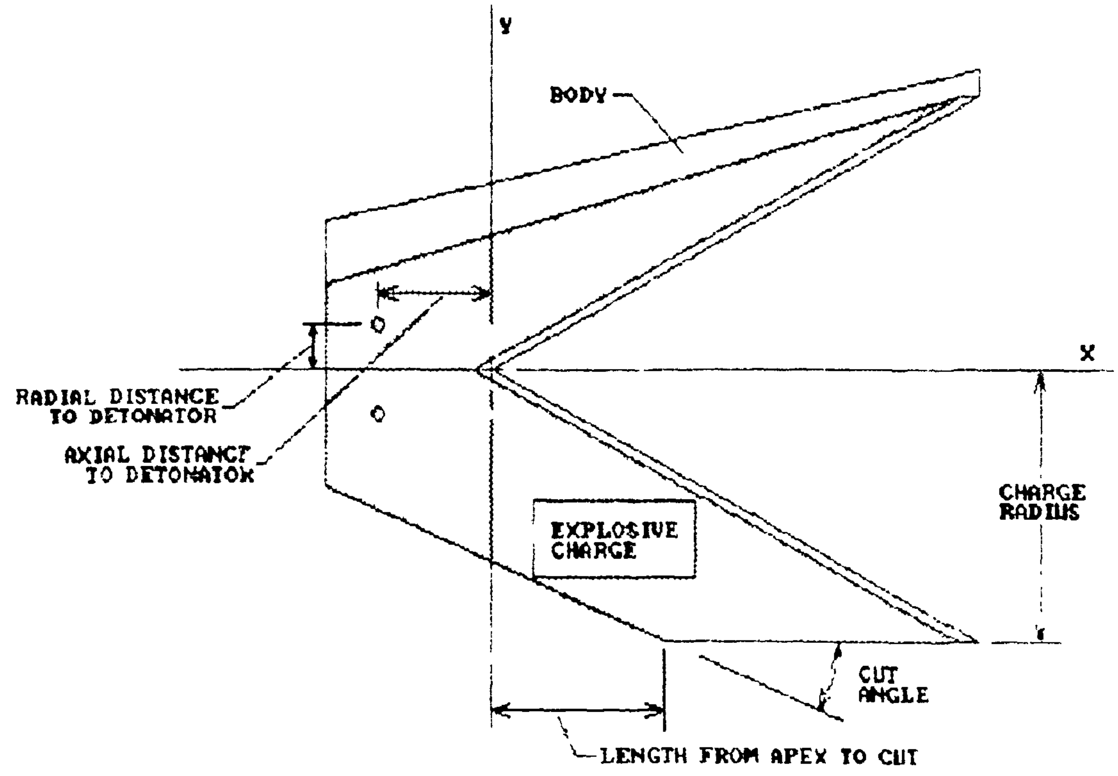


Figure 1. Body and explosive geometry input for LPASCC

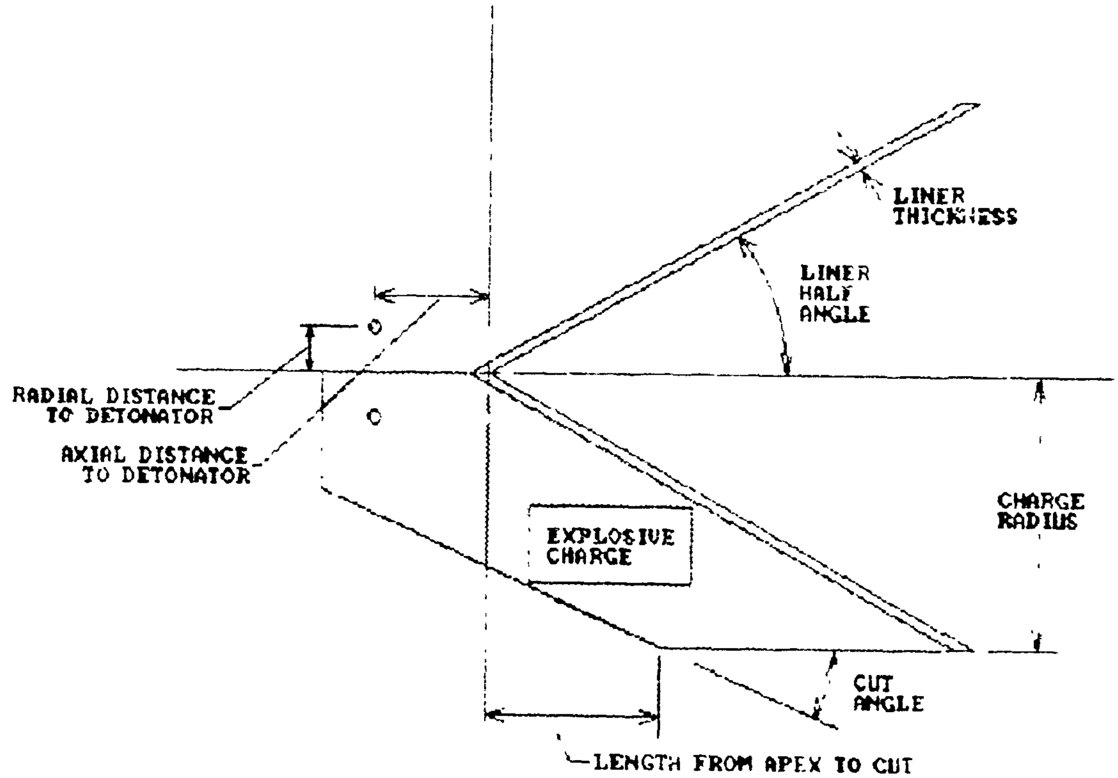


Figure 2. LPASCC input parameters for the cone liner driver CONEL

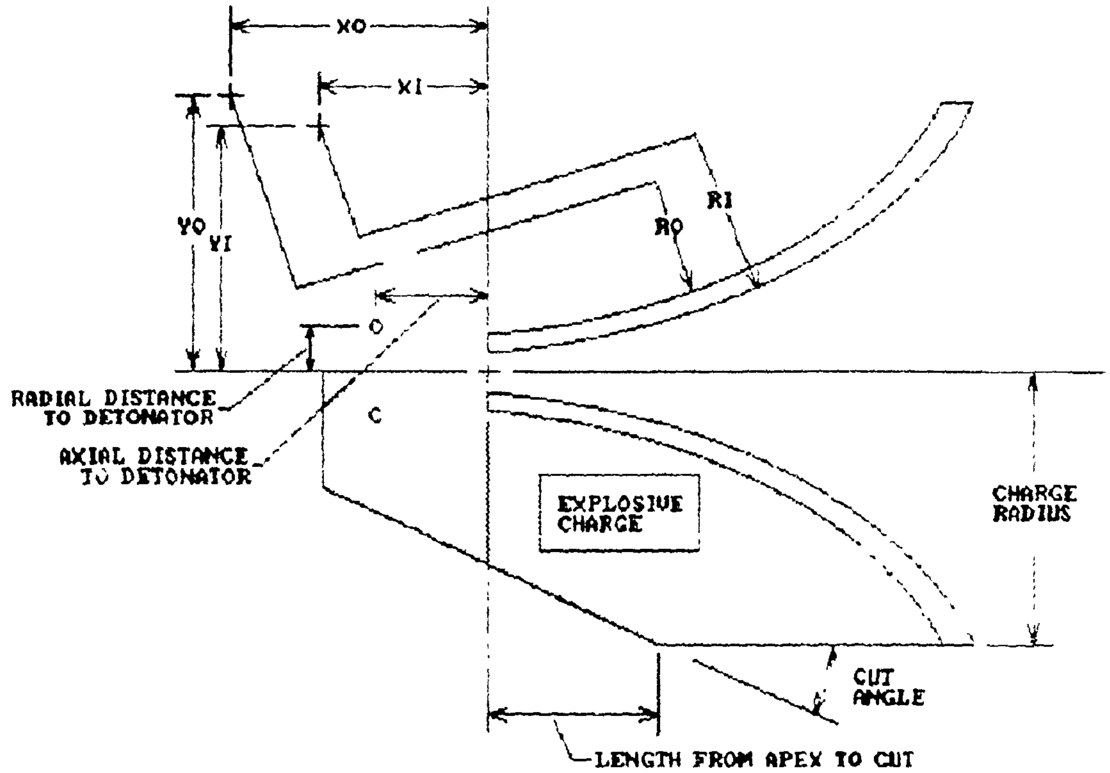


Figure 3. LPASCC input parameters for the trumpet liner drive TRUMPL

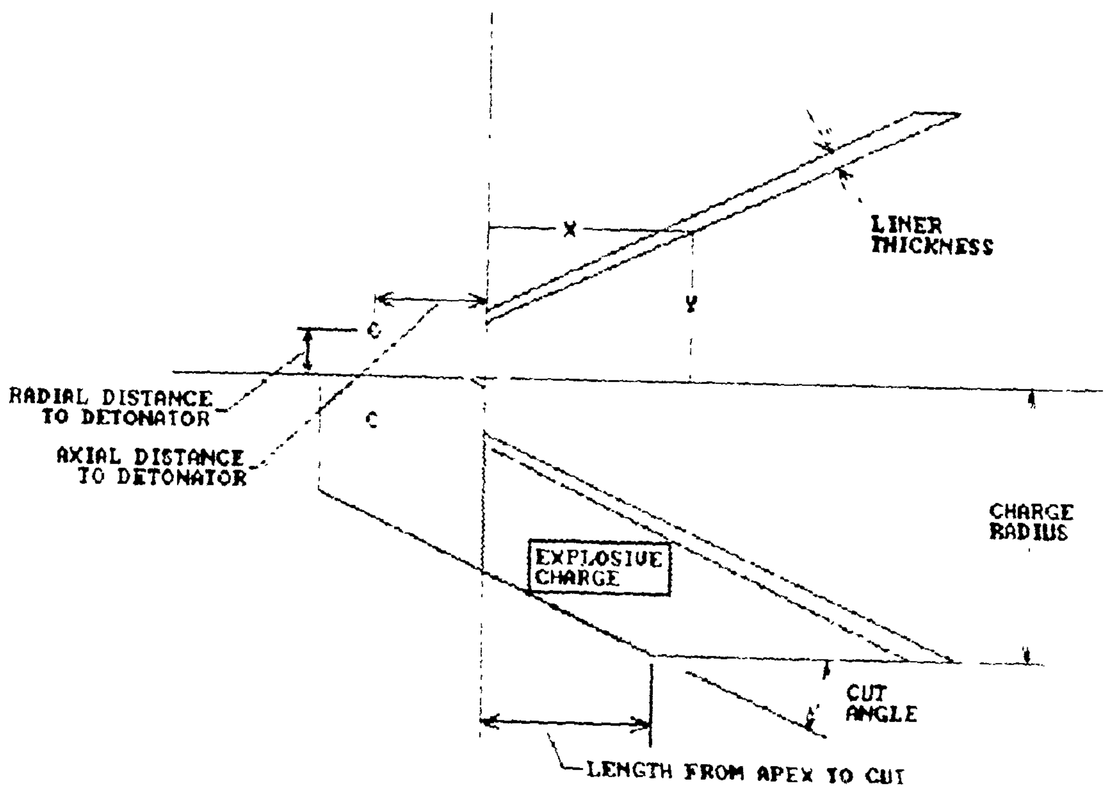


Figure 4. LPASCC input parameters for the variable liner drive VARIL

```
 1)JET VELOCITY (KM/S)
 2)SLUG VELOCITY (KM/S)
 3)COLLAPSE POINT VELOCITY (KM/S)
 4)COLLAPSE VELOCITY WRT COLLAPSE POINT (KM/S)
 5)COLLAPSE MACH NUMBER
 6)GURNEY VELOCITY (KM/S)
 7)COLLAPSE ANGLE (RADIANS)
 8)TAYLOR ANGLE (RADIANS)
 9)COLLAPSE POINT (MM)
10)COLLAPSE TIME (US)
11)JET MASS FRACTION
12)LINER POINT THICKNESS (MM)
13)LINER POINT AXIAL POSITION (MM)
14)LINER POINT RADIUS (MM)
15)LINER HALF ANGLE AT LINER POINT (RADIANS)
****JET PROFILE, ACCOUNTS FOR INVERSE GRADIENT****
16)JET PROFILE AXIAL POSITION (MM)
17)JET PROFILE RADIAL THICKNESS (MM)
18)ACCUMULATED JET MASS (G)
19)ACCUMULATED JET ENERGY (J)
ENTER DESIRED X AND Y VARIABLES:
```

Figure 5. GPASCC plotting menu

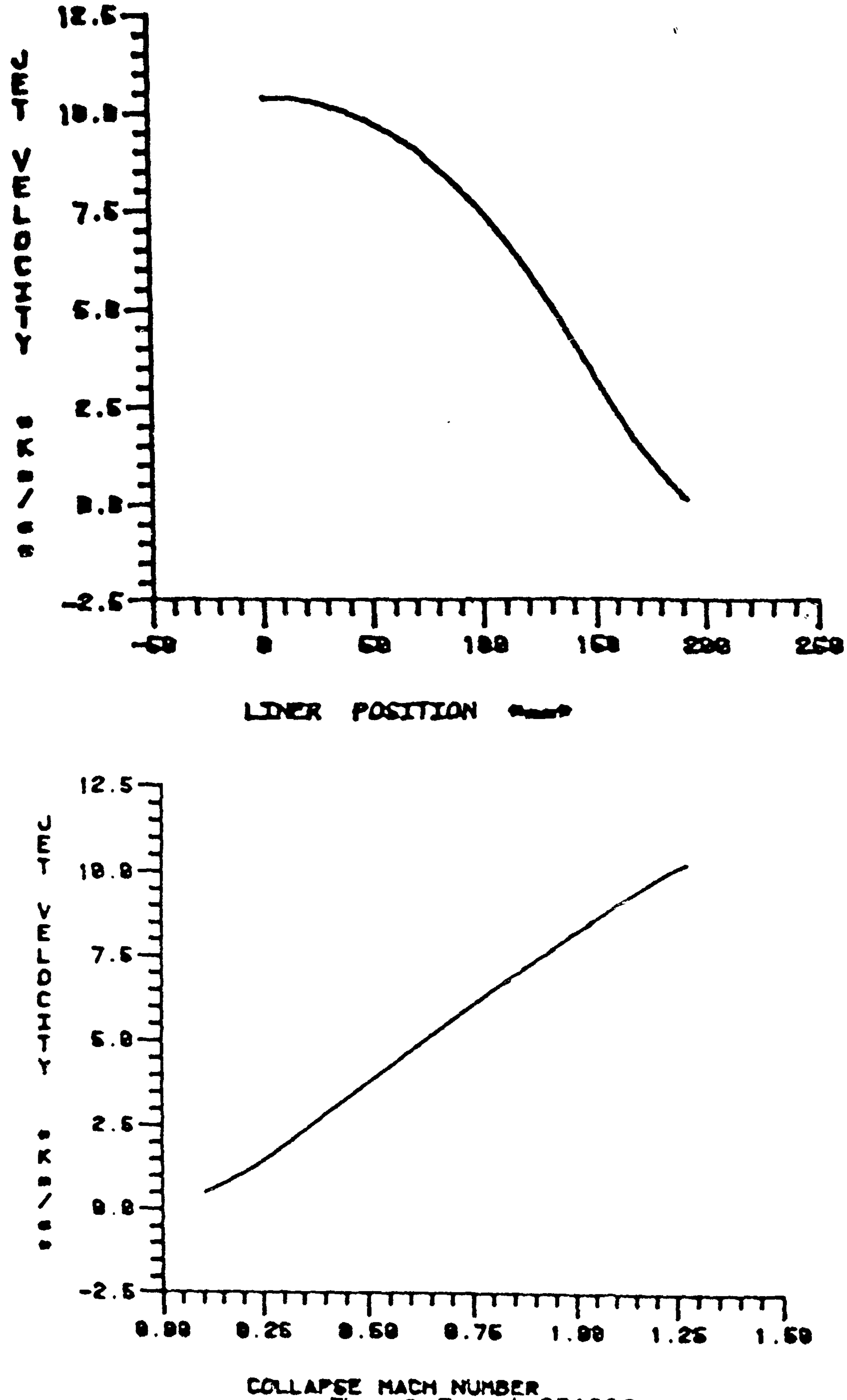
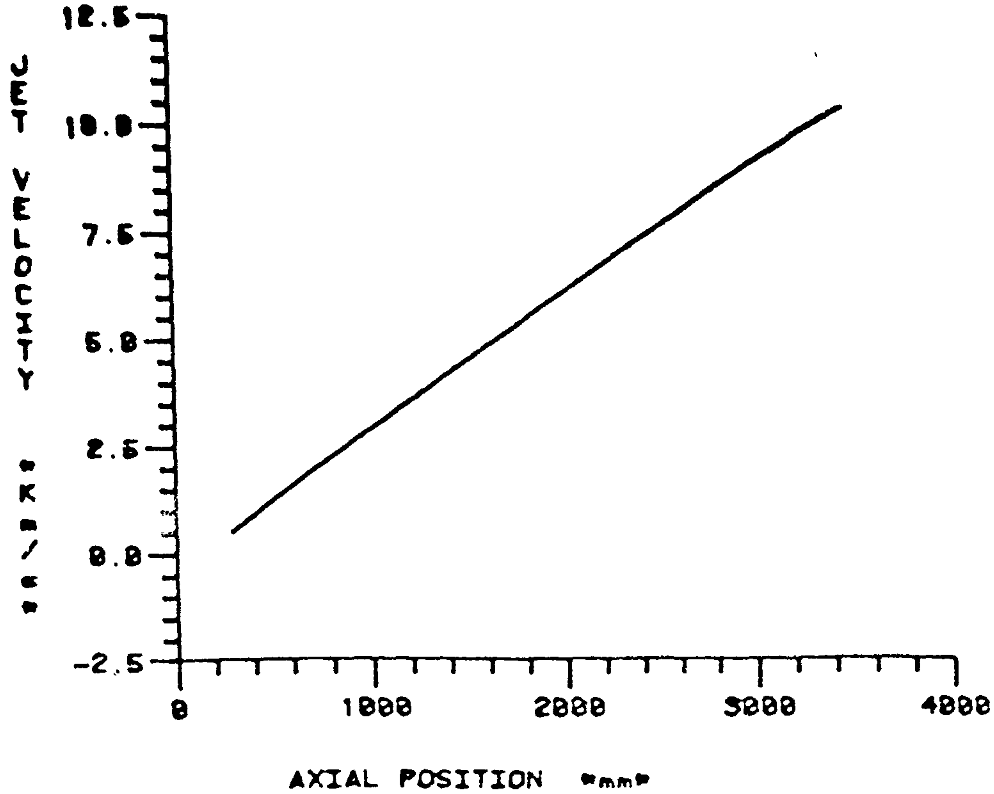


Figure 6. Example GPASCC output



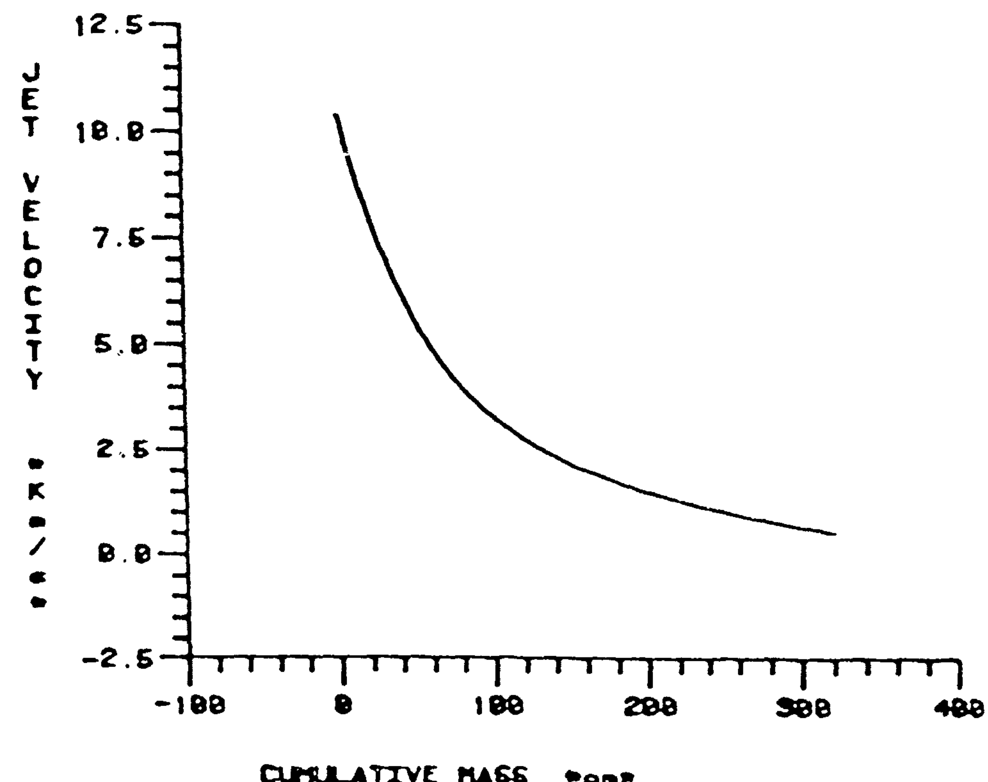
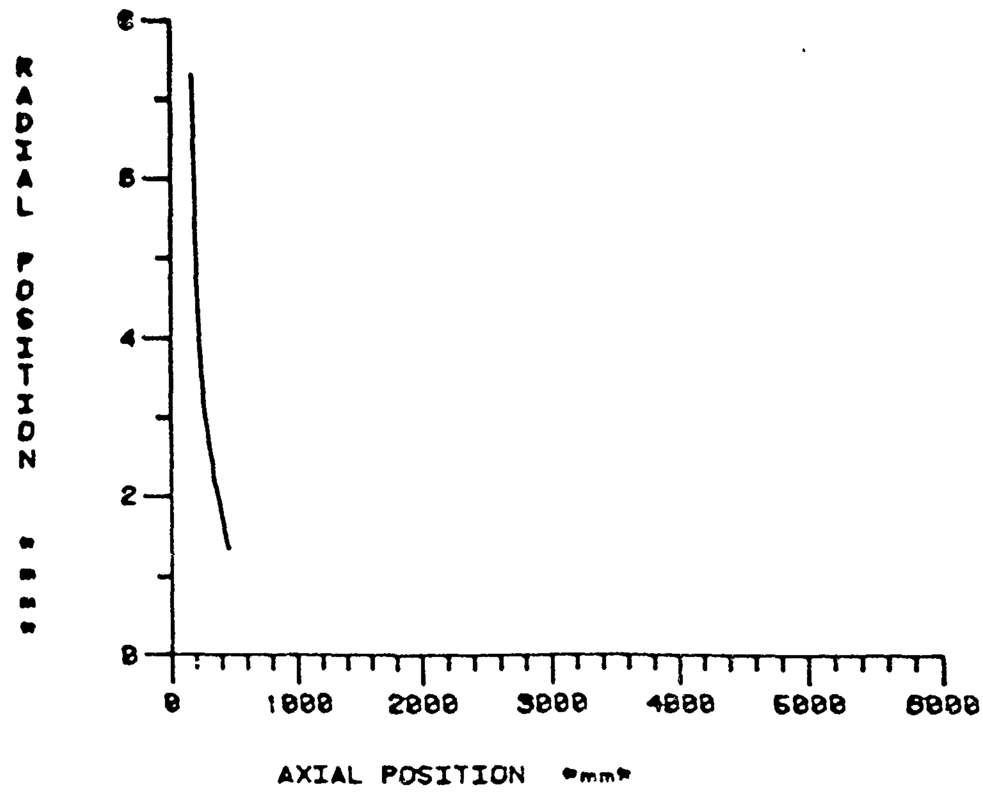


Figure 6. (cont)



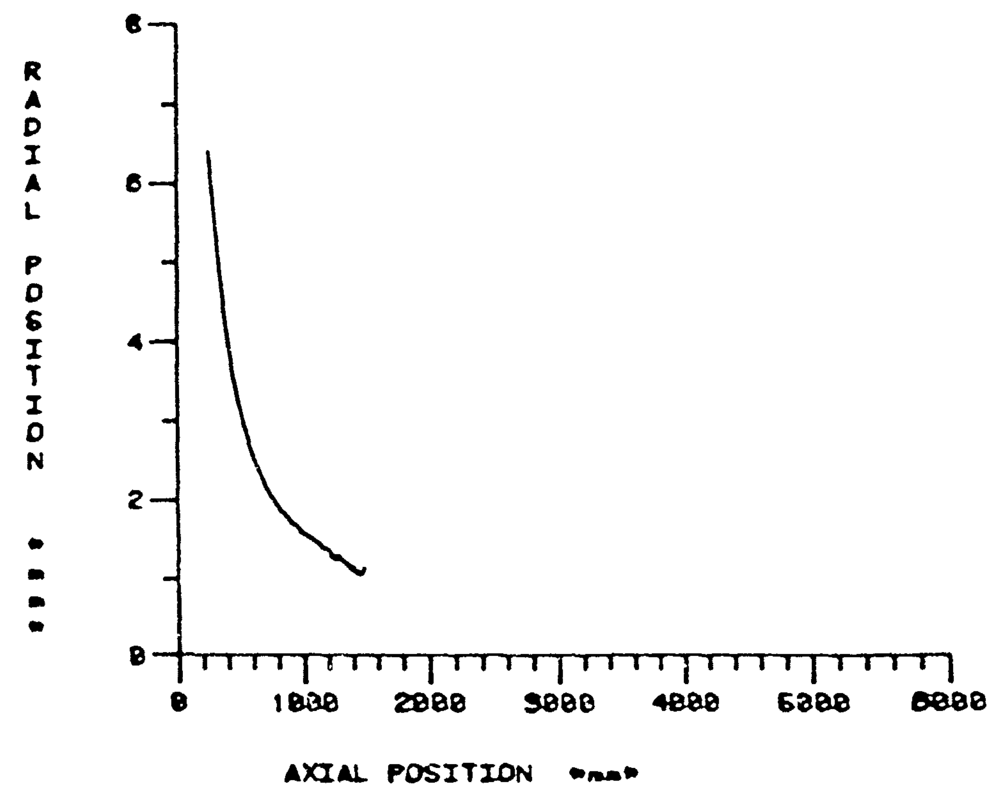
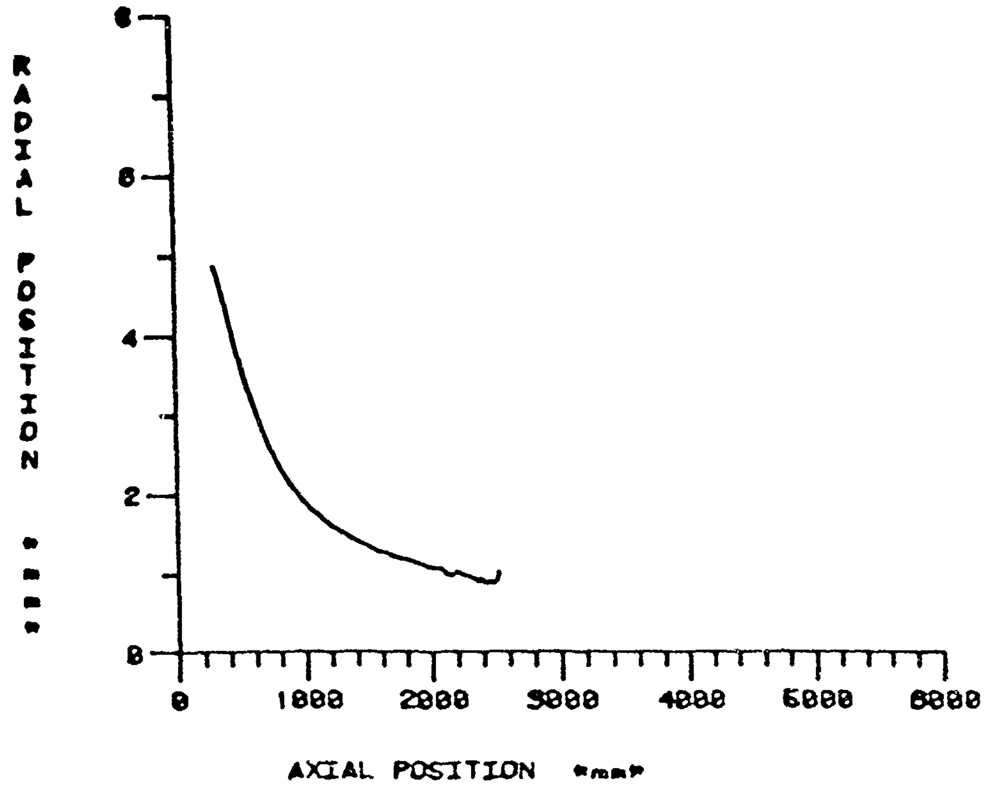


Figure 7. Example GPASCC output (jet profile at 50 μs intervals)



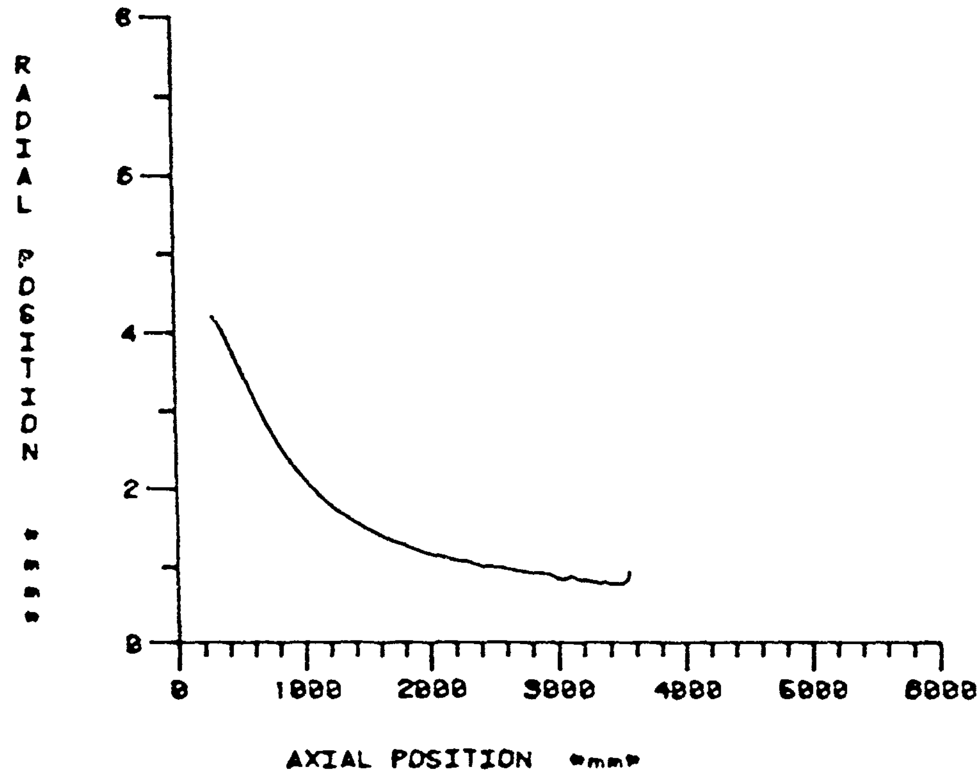
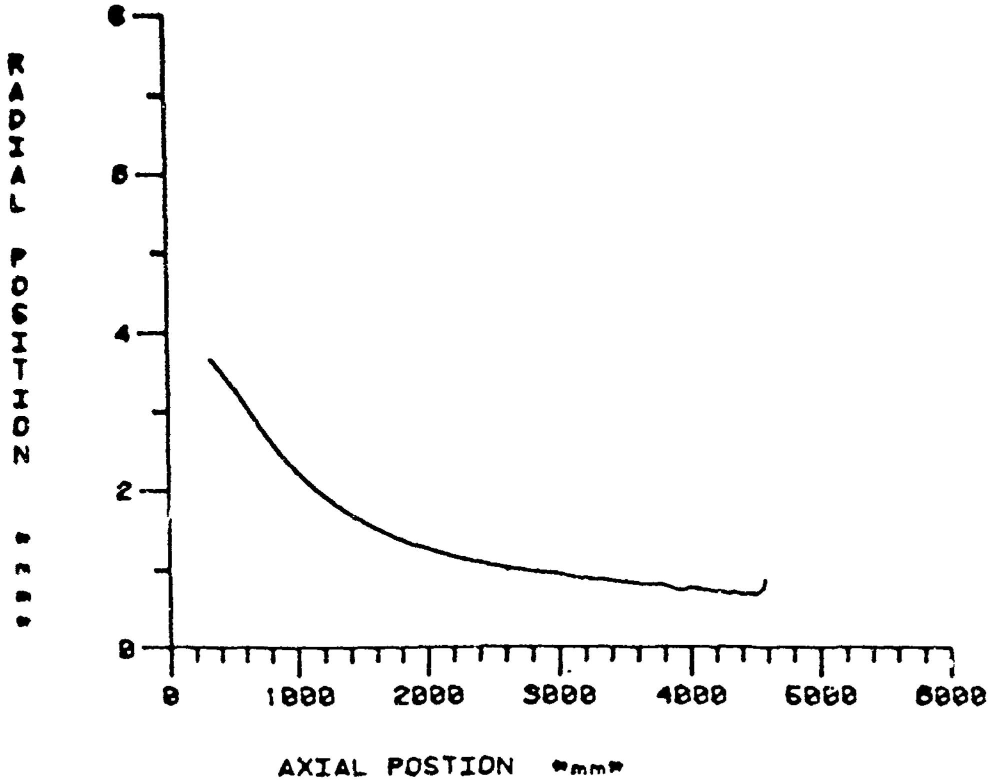


Figure 7. (cont)



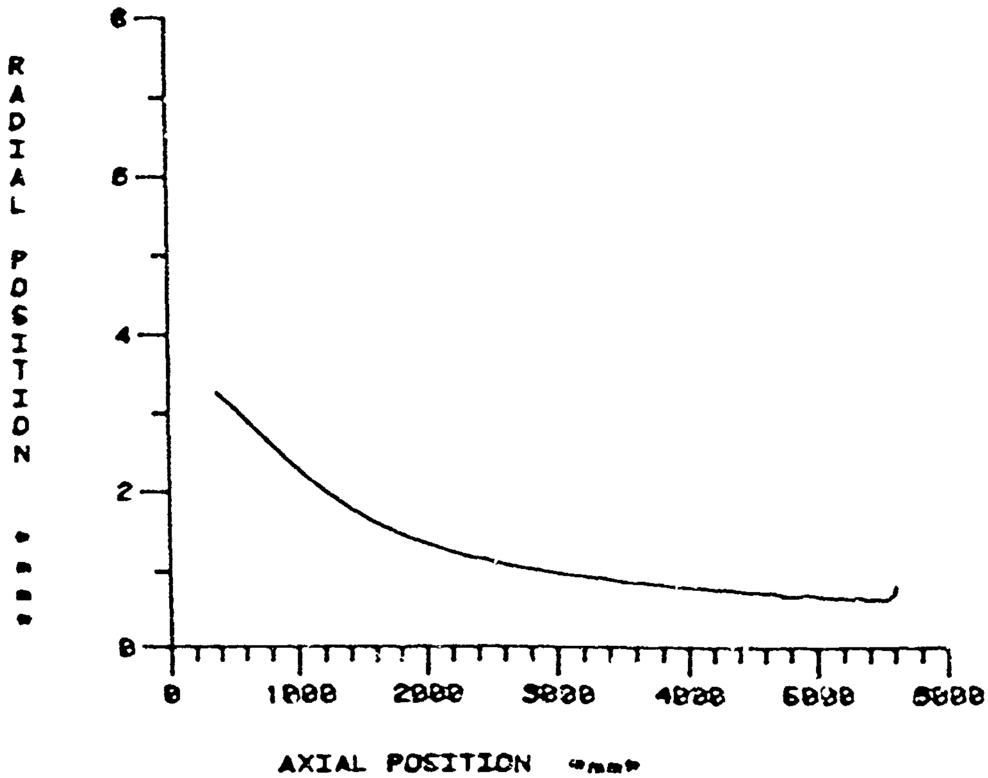


Figure 7. (cont)

REFERENCES

1. Pugh, E.M., Eichelberger, R.J., and Rostocker, N., "Theory of Jet Formation by Charges with Lined Conical Cavities," J. App. Phys. 23, pp. (5)532-536, 1952.

2. Chou, P.C. and Flis, W.J., "Recent Development in Shaped Charge Technology," Propellants, Explosives, Pyrotechnics 11, pp 99-114, 1986.

3. Cowperthwaite, M. and Zwisler, W.H., TIGER Computer Program Documentation. SRI Publication No. Z106, 1973.

APPENDIX A

PASCC1 INPUT DATA FORMAT

The input data format for PASCC1 is as follows.

```
-------
:ISHCH:
----------------                                         -----
:RHOL:CSL:RHOB:                                            *
----------------                                         ISHCH
:IPT:IGEOM:IGCM:                                         times
-------------------------------- ---------                 *
:R:X:A:XC:XL:XB:U:RHOC:CGUR:GAM: IPT times                 *
-------------------------------- ------- -               -----
```

Variable Definitions:

```
ISHCH = NUMBER OF SHAPED CHARGES TO BE ANALYZED
 RHOL = LINER DENSITY (Km/s)
  CSL = LINER MATERIAL SOUND SPEED (Km/s
 RHOB = BODY DENSITY (Km/s)
  IPT = NUMBER OF LINER POINTS TO BE INPUT
IGEOM = SHAPED CHARGE GEOMETRY (1 Linear. 2 Cylindrical)
 IGCM = CHARGE/MASS RATIO GEOMETRY (1 Linear. 2 Cylindrical)
    R = LINER POINT RADIUS (mm)
    X = LINER POINT AXIAL POSITION (mm)
    A = LINER HALF ANGLE AT LINER POINT (radians)
   XC = CHARGE LENGTH AT LINER POINT (mm
   XL = LINER THICKNESS AT LINER POINT (mm)
    U = DETONATION SWEEP VELOCITY ACROSS LINER POINT (Km/s)
 RHOC = CHARGE DENSITY (g/cc)
 CGUR = GURNEY CONSTANT (Km/s)
  GAM = EXPLOSIVE PRODUCTS CONSTANT GAMMA
```

APPENDIX B

PASCC1 OUTPUT DATA FORMAT

The output data format for PASCC1 is as follows:

```
 -------
 |ISHCH|
 ---------------                                             -----
 |RHOL|CSL|RHOB|                                               *
 ---------------                                               *
 |IJPT|IGEOM|                                                ISHCH
 -----------------                                     ----- times
 |U|RHOC|GAM|CGUR|                                     IJPT    *
 ----------------------------------------------        times   *
 |VJ|VS|V1|V|CMN|V0|B|DEL|X|BT|FMJ|XL|X0|R0|A|          *      *
 ----------------------------------------------        -----  -----
```

Variable Definitions:

```
ISHCH = NUMBER OF SHAPED CHARGES ANALYZED
 RHOL = LINER DENSITY (g/cc)
  CSL = LINER MATERIAL SOUND SPEED (km/s)
 RHOB = BODY DENSITY (g/cc)
 IJPT = NUMBER OF JET POINTS OUTPUT
IGEOM = SHAPED CHARGE GEOMETRY (1 Linear, 2 Cylindrical)
    U = DETONATION SWEEP VELOCITY ACROSS LINER POINT (Km/s)
 RHOC = CHARGE DENSITY (g/cc)
  GAM = EXPLOSIVE PRODUCTS CONSTANT GAMMA
 CGUR = GURNEY CONSTANT (Km/s)
   VJ = JET POINT VELOCITY (Km/s)
   VS = SLUG POINT VELOCITY (Km/s)
   V1 = COLLAPSE POINT VELOCITY (Km/s)
    V = COLLAPSE VELOCITY WITH RESPECT TO
        THE COLLAPSE POINT (Km/s)
  CMN = COLLAPSE MACH NUMBER
   V0 = FINAL GURNEY VELOCITY (Km/s)
    B = COLLAPSE ANGLE (radians)
  DEL = FINAL TAYLOR ANGLE (radians)
    X = COLLAPSE POINT POSITION (mm)
   BT = COLLAPSE TIME (μs)
  FMJ = JET MASS FRACTION
   XL = LINER POINT INITIAL THICKNESS (mm)
   X0 = LINER POINT INITIAL AXIAL POSITION (mm)
   R0 = LINER POINT INITIAL RADIAL POSITION (mm)
    A = LINER HALF ANGLE AT LINER POINT (radians)
```

APPENDIX C

SHAPED CHARGE CALCULATION EXAMPLE
81mm, 42 DEGREE COPPER LINE
COMP B EXPLOSIVE

PREPROCESSING:

```
COMMAND- etl,500
COMMAND- begin.lpascc,/pascci,dibrl.myid
 AT CY= 012 SN=PFSET
 AT CY= 002 SN=PFSET
*************LPASCC***************
    LINER INPUT DRIVER FOR PASCC
*********************************
ENTER THE NUMBER OF SHAPED CHARGES TO BE ANALYSED: 1
1)LINEAR SHAPED CHARGE
2)CYLINDRICAL SHAPED CHARGE
ENTER DESIRED SHAPED CHARGE GEOMETRY: 2
1)LINEAR CHARGE TO MASS CALCULATION
2)CYLINDERICAL CHARGE TO MASS CALCULATION
ENTER DESIRED CHARGE TO MASS CALCULATION METHOD: 2
1)NORMAL UNIFORM CHARGE FILL
2)NON-UNIFORM CHARGE FILL
ENTER DESIRED EXPLOSIVE CHARGE TYPE: 1

 1)LX-14, 1.82 G/CC
 2)OCTOL(85/15), 1.835 G/CC
 3)OCTOL(69/31), 1.778 G/CC
 4)COMP A3, 1.63 G/CC
 5)TNT, 1.63 G/CC
99)EXPLOSIVE VALUES MANUAL ENTRY
ENTER DESIRED EXPLOSIVE NUMBER: 99
ENTER EXPLOSIVE DENSITY (G/CC): 1.717
ENTER EXPLOSIVE DETONATION VELOCITY (KM/S): 7.98
ENTER EXPLOSIVE CONSTANT POLYTROPIC GAMMA: 2.705
ENTER EXPLOSIVE GURNEY CONSTANT (KM/S): 2.8

1)CYLINDRICAL CHARGE
2)CYLINDERICAL CHARGE WITH TAPERED CUT
ENTER DESIRED CHARGE CONFIGURATION NUMBER: 1
ENTER THE CYLINDERICAL CHARGE RADIUS (MM): 40.5

1)PLANE INITIATION
2)POINT INITIATION
ENTER DESIRED EXPLOSIVE INITIATION: 2
ENTER THE AXIAL DISTANCE OF THE INITIATION
POINT FROM THE LINER APEX (MM): 60.
```

```
ENTER THE RADIAL DISTANCE OF THE INITIATION
POINT FROM THE LINER APEX (MM): 0.

 1) NO BODY
 2) CONSTANT THICKNESS BODY
 3) VARIABLE THICKNESS BODY
ENTER DESIRED BODY TYPE NUMBER: 2
ENTER THE BODY THICKNESS (MM): 4.35

 1)COPPER
 2)ALUMINIUM 2024
 3)STAINLESS STEEL 304
 4)NICKEL
 5)TANTALUM
 6)MOLYBDENUM
99)MATERIAL VALUE MANUAL ENTRY
ENTER DESIRED BODY MATERIAL NUMBER: 2

 1)COPPER
 2)ALUMINIUM 2024
 3)STAINLESS STEEL 304
 4)NICKEL
 5)TANTALUM
 6)MOLYBDENUM
99)MATERIAL VALUE MANUAL ENTRY
ENTER DESIRED LINER MATERIAL NUMBER: 1

1) CONE LINER
2) TRUMPET LINER
3) VARIABLE LINER
ENTER DESIRED LINER TYPE NUMBER: 1
*************CONEL***************
 CONE LINER INPUT DRIVER FOR PASCC
*********************************

ENTER THE DESIRED NUMBER OF CONE PTS: 150

ALPHA = LINER HALF ANGLE (RADIANS)
    A = CONE THICKNESS FRACTION OF CYLINDER RADIUS
ENTER ALPHA AND A: 0.36651914, 0.046875
     STOP
      27100 MAXIMUM EXECUTION FL.
      0.819 CP SECONDS EXECUTION TIME.
 INITIAL CATALOG
 RP = 050 DAYS
 CT ID=     MYID PFN=DIBRL
 CT CY= 001 SN=PFSET   0000001664 WORDS.
COMMAND-
```

MAIN PROCESSING:

```
COMMAND- senator
---get rpascc,myid
    3 LINES
---list
   100 PASCC1,CM120000,T400,IO200,ST74C.
   110 COMMENT.(XXX-YYY,01291T),MYID
   120 BEGIN,PASCC1,/PASCC1,DIBRL,DOBRL,MYID.
---save rpascc
---bye
COMMAND- batch,rpascc,input,here
  NAME-PASCC6S, DISP-INPUT , ID-XX/
COMMAND- logout
```

POST PROCESSING:

```
COMMAND- files
--REMOTE OUTPUT FILES--
  PASCC67
COMMAND- batch,pascc67,local
COMMAND- senator
---old pascc67
    2 RECORDS/FILES
   46 LINES
---list
   100 S
   110 OBATCH       CREATED-            TODAY IS 03/25/88
   120
   130
   140          12/30/87   *****  NEW VERS OF SCL FOR NOS/VE
QUICK REF  *****
   150     NEW VERSION OF SCL FOR NOS/VE QUICK REFERENCE MANUAL,
PUB 60464018,
   160   REVISION F, LEVEL 688, IS NOW AVAILABLE TO USERS.
   170     CONTACT KATHY HUBERT, BLDG 350-N, ROOM 3, X 5878.
   180
   190 *EOR
   200 S
   210 1  74C  NOS/BE 1.5 LEV 664-J CYBER 74  05/14/87
   220  14.17.37.PASCC67  FROM FEY/XX
   230  14.17.37.IP  00000128 WORDS - FILE INPUT  , DC 04, ID= XX
XX
   240  14.17.38.PASCC1,CM120000,T4000,IO2000,ST74C.
   250  14.17.38.(XXX-YYY,01291T),MYID
```

```
   260  14.17.39.BEGIN,PASCC1,/PASCC1,DIBRL,DOBRL,MYID.
   270  14.17.40.AT CY= 012 SN=PFSET
   280  14.17.41.IFE,$MYID$.EQ.$NOME$,NOM.
   290  14.17.41.ENDIF,NOM.
   300  14.17.41.ATTACH,RPASC1,RPASC1,ID=PASCC1.
   310  14.18.07.AT CY= 004 SN=PFSET
   320  14.18.07.REQUEST,TAPE2,*PF.
   330  14.18.07.ATTACH,TAPE1,$DIBRL$,ID=$MYID$.
   340  14.18.07.AT CY= 001 SN=PFSET
   350  14.18.08.RPASC1.
   360  14.18.11.  CM LWA+1 = 14373B, LOADER USED  32400B
   370  14.35.18.     STOP
   380  14.35.18.      25600 MAXIMUM EXECUTION FL.
   390  14.35.18.    736.238 CP SECONDS EXECUTION TIME.
   400  14.35.18.CATALOG,TAPE2,$DOBRL$,ID=$MYID$.
   410  14.35.18.INITIAL CATALOG
   420  14.35.18.RP = 050 DAYS
   430  14.35.18.CT ID=      MYID PFN=DOBRL
   440  14.35.18.CT CY= 001 SN=PFSET   0000004032 WORDS.
   450  14.35.18.REVERT.
   460  14.35.19.OP  00000064 WORDS - FILE OUTPUT , DC 40, ID= XX
PASCC67
   470  14.35.19.MS    10240  WORDS  (    20480 MAX USED)
   480  14.35.19.CPA     446.248 SEC.      1115.617 ADJ.
   490  14.35.19.CPB     290.951 SEC.       290.951 ADJ.
   500  14.35.19.IO        1.688 SEC.          .422 ADJ.
   510  14.35.19.CM   20532.053 KWS.       313.294 ADJ.
   520  14.35.19.SS    74C                1720.285
   530  14.35.19.EST. COST AT $250/HR. - $  119.46
   540  14.35.19.PP       10.156 SEC.      DATE 03/25/88
   550  14.35.19.EJ  END OF JOB, XX
---bye
COMMAND- etl,500
COMMAND- begin,gpascc,/pascc1,dobrl,myid
 AT CY= 012 SN=PFSET
 AT CY= 001 SN=PFSET
 AT CY= 003 SN=PFSET
***********************************
************GPASCC***************
***********************************
    CURRENT DATA SET:1
1)JET VELOCITY (KM/S)
2)SLUG VELOCITY (KM/S)
3)COLLAPSE POINT VELOCITY (KM/S)
4)COLLAPSE VELOCITY WRT COLLAPSE POINT (KM/S)
5)COLLAPSE MACH NUMBER
6)GURNEY VELOCITY (KM/S)
7)COLLAPSE ANGLE (RADIANS)
```

```
8)TAYLOR ANGLE (RADIANS)
9)COLLAPSE POINT (MM)
10)COLLAPSE TIME (US)
11)JET MASS FRACTION
12)LINER POINT THICKNESS (MM)
13)LINER POINT AXIAL POSITION (MM)
14)LINER POINT RADIUS (MM)
15)LINER HALF ANGLE AT LINER POINT (RADIANS)
****JET PROFILE, ACCOUNTS FOR INVERSE GRADIENT****
16)JET PROFILE AXIAL POSITION (MM)
17)JET PROFILE RADIAL THICKNESS (MM)
18)ACCUMULATED JET MASS (G)
19)ACCUMULATED JET ENERGY (J)
ENTER DESIRED X AND Y VARIABLES: 13,1
INPUT THE NUMERIC CODE FROM THE LIST BELOW WHICH SPECIFIES YOUR
TERMINAL TYPE.
 1. TEK 4010                            2. TEK4014
 3. TEK4014-1                           4. TEK4027
 5. TEK4112                             6. VT100 RETROGRAPHICS
 7. GENISCO G-1000                      8. TEK4113
 9. TAB 132/15-G                       10. MODGRAPH G100
11. TEK4027 CENTERED                   12. TEK4027 ROTATED
13. IBM XY/750 PLOTTER                 14. TEK4663 2-PEN PLOTTER
15. TEK4662 1-PEN PLOTTER              16. TEK4662 8-PEN PLOTTER
17. TEK 4054                           18. TEK4105
19. TEK4107                            20. TEK4109
21. TEK4115                            22. HP2623A
23. DATAMEDIA DSCAN10(4010)            24. DATAMEDIA DSCAN10(4027)
25. GRIDVT100                          26. MACINTOSH TEKALIKE
27. MACINTOSH VERSATERM                28. CIT-467(4014)
29. CIT-467(4027)

 MY TYPE IS =3
ENTER X TITLE(40 CHARACTERS MAX):
LINER POSITION  *mm*
ENTER Y TITLE(40 CHARACTERS MAX):
JET VELOCITY  *Km/s*
```

(at this point plots are produced)

DISTRIBUTION LIST

Commander
Armament Research, Development and Engineering Center
U.S. Army Armament, Munitions and Chemical Command
ATTN: SMCAR-IMI-I (5)
SMCAR-CO
SMCAR-TD
SMCAR-TDC
SMCAR-AE (3)
SMCAR-AEE (3)
Picatinny Arsenal, NJ 07806-5000

Commander
U.S. Army Armament Research, Development and Engineering Center
ATTN: AMSMC-GCL(D)
AMSMC-DSM-B (D)
Picatinny Arsenal, NJ 07806-5000

Administrator
Defense Technical Information Center
ATTN: Accessions Division (12)
Cameron Station
Alexandria, VA 22304-6145

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-MP
Aberdeen Proving Ground, MD 21005-5066

Commander
Chemical Research, Development and Engineering Center
U.S. Army Armament, Munitions and Chemical Command
ATTN: SMCCR-MSI
Aberdeen Proving Ground, MD 21010-5423

Commander
Chemical Research, Development and Engineering Center
U.S. Army Armament, Munitions and Chemical Command
ATTN: SMCCR-RSP-A
Aberdeen Proving Ground, MD 21010-5423

Chief
Benet Weapons Laboratory, CCAC
Armament Research, Development and Engineering Center
U.S. Army Armament, Munitions and Chemical Command
ATTN: SMCAR-CCB-TL
Watervliet, NY 12189-5000

Commander
U.S. Army Armament, Munitions and Chemical Command
ATTN: SMCAR-ESP-L
Rock Island, IL 61299-6000

Director
U.S. Army TRADOC Systems Analysis Activity
ATTN: ATAA-SL
White Sands Missile Range, NM 88002

Director
Ballistic Research Laboratory
ATTN: AMXBR-OD-ST
SLCBR-TB-EE
Aberdeen Proving Ground, MD 21005-5066

Commander
Naval Weapons Center
ATTN: L. Smith, Code 3205
A. Amster, Code 385
R. Reed, Jr., Code 388
K.J. Grahaam, Code 3835
China Lake, CA 93555

Director
Lawrence Livermore National Laboratory
University of California
P.O. Box 808
ATTN: M. Finger
Livermore, CA 94550

Director
Los Alamos National Laboratory
ATTN: Group T14
Los Alamos, NM 87545

Director
Sandia National Laboratory
Albuquerque, NM 87185

Commander
Naval Surface Weapons Center
ATTN: Code G13
Dahlgreen, VA 22448

Commander
Naval Surface Weapons Center
ATTN: L. Roslund, R122
M. Stosz, R121
Code X211, Lib
E. Zirnet, R13
R.R. Bernecker, R13
J.W. Forbes, R13
S.J. Jacobs, R10
C. Dickinson
J. Short, R12
Silver Spring, MD 20910

Air Force Armament Laboratory
ATTN: J. Forster, AFATL-MNW
G. Parson, AFATL-MNE
Eglin Air Force Base, FL 32542-5434